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Action: Creating underpasses to influence animal movement/dispersal

Key Messages:

- Underpasses have the potential to significantly decrease wildlife mortality and thereby extend animal movement/dispersal if designed correctly
- Proximity to human activity may be a key deterrent in underpass usage by wildlife
- Strategic placement of natural habitat elements may encourage underpass use
- Underpasses may accommodate many species of different sizes and types of movement
- While there may be a target species, other species who are likely to also use the underpass should be taken into account
- Underpasses must be strategically designed to bar accessibility to dangerous alternative crossing options
- Wildlife usage may not be immediate
- Underpasses require regular maintenance to make them a viable long-term solution

Background Information

As urbanization and human expansion increases, wildlife are facing habitat destruction and fragmentation. Roads cutting through the landscape decrease habitat connectivity, creating a barrier effect that restricts animal movement resulting in isolated populations that are less stable and more vulnerable to extinction (Forman and Alexander, 1998). Additionally, roads are a cause of mortality for many species, particularly those that are large, rare, or who regularly come into contact with them which can be detrimental to their conservation status (Bennett, 1991).

One solution to this issue is to perforate the barrier by constructing underpasses that provide safe passage for animals without disrupting traffic, but the degree to which these successfully mitigate car related deaths and facilitate animal movement/dispersal depends largely on location and design. Oftentimes, underpasses are created with a single species in mind, a strategy that Clevenger and Waltho (2000) caution naively ignores the fact that species function in tandem with each other and are units of a larger ecological system. While some species come from more open habitats, others are used to a densely vegetated and structurally complex environment and may avoid cleared areas such as roads (Goosem, Weston, and Bushnell, 2005). To encourage wildlife to use underpasses, careful consideration must be taken to ensure that the design is appealing and they are intentionally structured to be the only viable means of passage to discourage animals from foregoing them in favor of dangerous routes (Dodd Jr., C, Barichivich, W., and Smith, L., 2003, Braden et al., 2008). Additions such as wildlife fencing may encourage underpass use and reduce mortality if they are an appropriate length, but the degree to which they are helpful is dependent on location as well (Huisjer et al., 2016). Once an underpass is constructed it may take a while to begin to see significant changes in animal movement, and usage may not immediately occur (Braden et al., 2008). A wildlife underpass must be strategically planned and will require additional funding for regular upkeep if it is to be successful in the long term.

Supporting Evidence from Individual Studies

1. A study by Clevenger and Waltho, (2000) on the effectiveness of a wildlife underpass in Banff National Park, Alberta, Canada at increasing habitat connectivity in a multispecies context. Eleven underpasses were monitored for 35 months to develop species performance ratios (observed crossing frequency to expected crossing frequency). Clevenger and Waltho (2000) used a null model to evaluate whether underpasses limited large mammal movement in species-specific ways and found that carnivores and ungulates responded differently depending on the variables. For carnivores, underpass usage was most significantly influenced by variables related to proximity to human use and development and was least influenced by landscape and structural variables (Clevenger and Waltho, 2000). The opposite was true for ungulates. Clevenger and Waltho (2000) suggested that for underpasses designed based on topography, habitat quality, and location, human activity must also be managed if it is to be more than minimally successful.

2. A study by Goosem, Weston, and Bushnell (2005) on the effectiveness of rope bridge arboreal overpasses and faunal underpasses in restoring habitat connectivity in tropical rainforests of Queensland, Australia. The underpasses were designed to accommodate multiple species with but with additional consideration for the two target species, Lumholtz's tree kangaroo and the Southern Cassowary (Goosem, Weston, and Bushnell, 2005). Underpasses were furnished with logs, soil, rocks, branches, and litter to mimic natural rainforest habitat, and a planted corridor was established at the entrances to attract animals and provide cover between the forested areas and the large clearings found near roads (Goosem, Weston, and Bushnell, 2005). Wildlife use was monitored using sand traps and cameras and roadkill data was collected for 12 months prior to underpass installation. Many terrestrial rainforest species were observed using the underpasses along with two uses by the target species Lumholtz's tree kangaroo (Goosem, Weston, and Bushnell, 2005). Compared to areas along the highway without underpasses, road related mortality was lower at the sites where underpasses were available (Goosem, Weston, and Bushnell, 2005).

3. A study by Dodd Jr., C, Barichivich, W., and Smith, L., (2003) on the effectiveness of a barrier wall-culvert system constructed in Paynes Prairie State Preserve, Alachua County,

Florida to reduce wildlife mortality and facilitate safe passage for some animals. Animal mortality was monitored for one year following construction and was down 93.5% (excluding hylid tree frogs) compared to records from one year prior, with 158 roadkills (excluding hylid tree frogs) vs 2411 (Dodd Jr., C, Barichivich, W., and Smith, L., 2003). Some wildlife found dangerous alternative routes to the barrier wall-culvert such as overhanging vegetation, maintenance road access, etc. that could be corrected with routine maintenance (Dodd Jr., C, Barichivich, W., and Smith, L., 2003).

4. A study by Huisjer et al. (2016) on the effectiveness of wildlife fencing and crossing structures on reducing wildlife-vehicle collisions and providing safe passage along highways in western Montana, USA. They investigated whether fence length influenced large mammal use of underpasses by placing wildlife cameras at the entrance to 23 underpasses for one year (Huisjer et al., 2016). Huisjer et al. (2016) found that to reduce wildlife-vehicle collisions, fences should be >5 km, however, longer fences alone do not necessarily guarantee underpass use and location should be taken into consideration as well.

5. A study by Braden et al. (2008) on underpass use by Florida key deer along a highway in the Big Pine Key corridor, Florida, USA. Fencing, deer guards, and two underpasses were constructed to reduce vehicle collisions and minimize deer mortality. Braden et al. (2008) studied the effects of these modifications on deer movement by comparing annual deer ranges and movements pre and post construction, deer-vehicle collisions pre and post construction, and underpass use (Braden et al., 2008). Their results indicated no difference in annual deer ranges and movements pre and post construction but found a 94% reduction in deer-vehicle collisions inside the segment with fencing. Underpass use increased overtime, suggesting that there may be an acclimation period following installation (Braden et al., 2008). Use in the southern region was greater than in the northern, possibly because of a lack of alternative options in the south vs the north where radio collaring revealed deer going around the project (Braden et al., 2008).

Conclusions and Recommendations

When constructing wildlife underpasses, one must first decide who is meant to use them. It is important to design a corridor with the target species in mind by considering things like habitat preference, movement style, and behavior to create an underpass that they are willing to use. However, it is also necessary to take into account that what appeals to one species may discourage another and could result in an uneven distribution of species across the landscape and potentially lead to a cascade of problematic ecological effects. Attention should also be given to additional measures such as fencing and other exclusion tools to discourage accessibility to unsafe alternative routes and encourage wildlife to seek and utilize the underpass. Once an underpass has been established, regular monitoring and upkeeps is necessary to understand how it is being used and where it could be improved to be more effective.

Supporting Studies

1. Clevenger, A.P. & Waltho, N. 2000. Factors influencing the effectiveness of wildlife underpasses in Banff national park, Alberta, Canada. *Conservation Biology, 14*(1), 47-56. Retrieved from https://arc-solutions.org/wp-content/uploads/2012/03/Clevenger-Waltho-2000-Factors-Influencing-the-Effectiveness-of-Wildlife-Underpasses-in-Banff-National-Park-Alberta-Canada.pdf

2. Goosem, M., Weston, N., & Bushnell, S. 2005. Effectiveness of rope bridge arboreal overpasses and faunal underpasses in providing connectivity for rainforest fauna. Retrieved from https://escholarship.org/uc/item/8br4h1kb

3. Dodd Jr., C.K., Barichivish, W.J., & Smith, L.L. 2003. Effectiveness of a barrier wall and culverts in reducing wildlife mortality on a heavily traveled highway in Florida. *Biological Conservation, 118*(5), 619-631. doi: https://doi.org/10.1016/j.biocon.2003.10.011

4. Huijser, M.P., Fairbank, E.R., Camel-Means, W., Graham, J., Watson, V., Basting, P., & Becker, D. 2015. Effectiveness of short sections of wildlife fencing and crossing structures along highways in reducing wildlife–vehicle collisions and providing safe crossing opportunities for large mammals. *Biological Conservation, 197*, 61-68. doi: https://doi.org/10.1016/j.biocon.2016.02.002

5. Braden, A.W., Lopez, R.R., Roberts, C.W., Silvy, N.J., Owen, C.B., & Frank, P.A. Florida Key deer Odocoileus virginianus clavium underpass use and movements along a highway corridor. *Wildlife Biology, 14*(1), 155-163. doi: https://doi.org/10.2981/0909-6396(2008)14[155:FKDOVC]2.0.CO;2

References

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Forman, R. T. T. & Alexander, L. E. 1998. Roads and their major ecological effects. *Annual Review of Ecology and Systematics, 29*, 207-231. Retrieved from https://www.edc.uri.edu/nrs/classes/nrs534/NRS_534_readings/FormanRoads.pdf